

An Historic Building Conversion to Research Usage and Post Occupancy Commissioning: Lessons Learned



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History of Charlestown Navy Yard

- ✍ Charlestown is the site of one of six navy yards established during the American Revolution to build warships for the fledgling nation.
- ✍ For nearly 175 years, as wooden hulls and muzzle-loading cannon gave way to steel ships and sophisticated electronics, the yard evolved to meet the changing needs of a changing navy.
- ✍ By the end of World War II the Navy had three annexes and a Naval air station on Boston Harbor.

History of Charlestown Navy Yard

- ✍ Both skilled and unskilled laborers were employed in the Charlestown Navy Yard, including dozens of specialized and skilled trades.
- ✍ In the 1830's, the Charlestown Navy Yard earned recognition for its ropemaking facility, which was the only one serving the US Navy at the time.
- ✍ In 1850, the Charlestown Navy Yard completed its first steamer combining the new technologies of steam and iron.

History of Charlestown Navy Yard

- ✍ The Charlestown Navy Yard served the United States well for over another century.
- ✍ Finally, on April 16, 1973, Captain R. L. Arthur, the Navy Yard commander, announced the closing of the Charlestown yard. The formal disestablishment ceremony took place on July 1, 1974.

Charlestown Navy Yard Today

- ✍ The National Park Service now operates and maintains an important part of the ship yard.
- ✍ The Park Service and the US Navy preserve the USS Constitution and the USS Cassin Young as representatives of the kinds of vessels built in this yard. Together they represent a 200-year-old tradition of building fine ships for the Navy.
- ✍ The remainder of the yard is owned by the Boston Redevelopment Authority and is not open to tours.
- ✍ MGH's first CNY research building (Building 149) opened in 1988

CNY Building 114

- ✍ Building 114 was originally the site of the Navy's wooden boat shop, where raw wood was milled and shaped into what would become the backbones of ships. It was known as the Saw Mill and Spar Shed.
- ✍ It remained closed for nearly 30 years before Partners/MGH purchased it. The project had many architectural and access challenges due to its history and location on the Boston HarborWalk.
- ✍ Building 114 opened as MGH's newest research building in 2001, as part of Partners/MGH's over \$300 million research program.

CNY Building 114 Today

Architectural Rendering





CNY Building 114 Today





- ✍ Supports more than 250 scientists engaged in basic science – the backbone of medicine.
- ✍ The Center for Aging, Genetics and Neurodegeneration pursues treatments for disorders such as Alzheimer's, Parkinson's, Lou Gehrig's and Huntington's diseases.
- ✍ The MGH and Children's Hospital Combined Program in Pediatric Gastroenterology and Nutrition focuses on host defenses against microbial-epithelial interaction as the basis for disease with Harvard Medical School.
- ✍ The Center for Engineering in Medicine focuses on the interface of biomedical sciences and microsystems technologies.
- ✍ Labs affiliated with Pediatric Surgery and Cardiovascular Research.

Building Delivery Method

Traditional MGH Construction / Renovation

-  MGH owns the research space
-  Construction Manager and design / bid / construct

CNY Building 114

-  Outside developer owned the historic building.
-  Developer agreed to do a gut renovation.
-  Developer agreed to turn it into a state of the art biomedical research facility.
-  Developer delivered building on a turn key basis to MGH.

The project did NOT include a formal commissioning (Cx) process.

Post-Occupancy Commissioning (Cx) Approach

- ✍ MGH and its independent consultants conducted post occupancy commissioning at the conclusion of this new building delivery approach.
 - ✍ To determine if the building systems met the requirements of its occupants
 - ✍ To identify punch list or uncompleted items
- ✍ The post occupancy Cx effort was very successful.
 - ✍ It identified several issues including capacity, workmanship and inappropriate Value Engineering deletions to the scope.
 - ✍ It created one monetized list that helped in resolving problems.

Electrical Post-Occupancy Cx Approach

- ✍ Emergency power supply system acceptance test
 - ✍ Full NFPA 110 acceptance test, requiring a 2-hour normal power outage followed by a 2-hour generator set full load test, using actual building emergency power loads supplemented by a resistive load bank as necessary.
- ✍ Sampled panelboards and transformers were opened for inspection of breakers, bussing, cables, etc.
- ✍ Sampled ground wiring was de-terminated (lifted) to ascertain the existence or absence of isolated grounding equipment.
- ✍ During the field walkdowns, we recorded as-found field information for a new main electrical one-line diagram.

An Unexpected Advantage of Post-Occupancy Electrical Cx

- ✍ Several weeks of main electrical load profiles provided a normal power base load from which to predict future building load growth.
- ✍ Emergency power supply system (EPSS) loading provided an emergency power base load from which to predict future building load growth.
- ✍ Based on the planned shutdown, MGH believes that this building could run on emergency power for an extended period.

Electrical Findings – Emergency Power System

- ✍ The EPSS failed the “cold-starting” portion of its NFPA-110 commissioning test. It took more than the Code-required 10 sec to get emergency power to the life safety system.
- ✍ Chiller VFD tripped during initial ATS transfer.
- ✍ Two circuit breakers in the generator distribution panel had incorrect trip units installed, resulting in a code violation from their feeder cables being improperly protected.

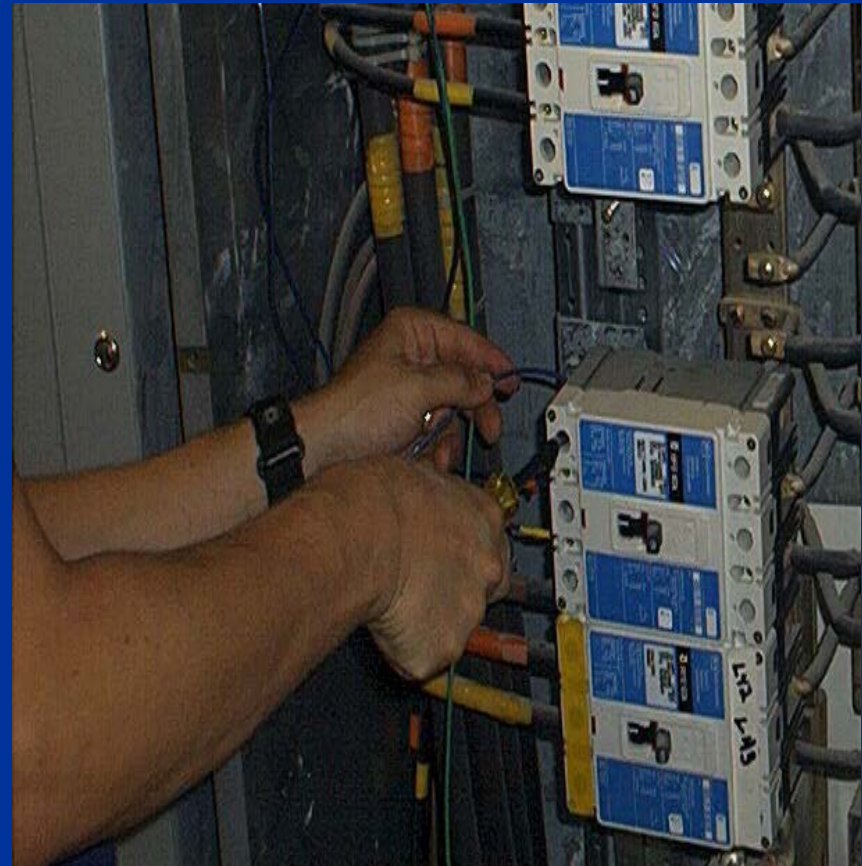
Some Findings Were Obvious

- ✍ The generator break-glass emergency shutdown switch on the wall near the generator set enclosure had cracked (almost broken through) glass in front of the button.
- ✍ When this glass weakens further and breaks, the generator would either fail to start or stop immediately.



Some Findings Were Not So Obvious

- ✍ This wire in a 480 volt normal power distribution panel was so loose that it was in danger of falling off the breaker.
- ✍ MGH's electrician fixed it immediately because of the hazard it represented.

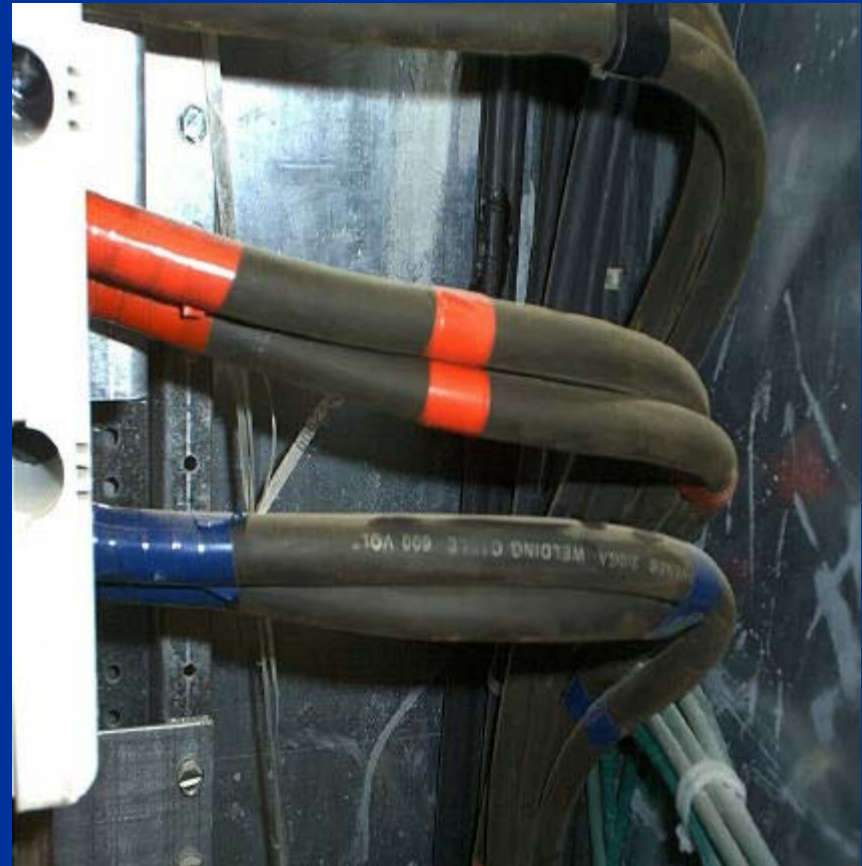


Electrical Findings – Emergency Power system

- ✍ Six panels were required to be Isolated Grounding (IG) type, but testing verified that they were not IG type.
- ✍ Several items of fire alarm extender equipment were powered by the equipment system rather than the emergency power (life safety) system.
- ✍ 225 KVA transformer primary and secondary feeders were found to be smaller welding cable installed in embedded conduit rather than the larger correct type of cable as required by CDs.

Electrical Findings – Improperly Substituted Cable

- ✍ The Contractor hired its own Code consultant to dispute our contention that this welding cable must be replaced.
- ✍ While the dispute was going on, MGH infrared-scanned the cable and proved it was overheating. MGH replaced the cable and subtracted the cost from the Contractor's retainage.



Previous Electrical Testing Results Not Followed Through

- ✍ Some findings from previous electrical testing had not been corrected despite Contractor's claims that corrections had occurred.
- ✍ This broken circuit breaker was still in use.



Missing and Incorrect Electrical System Documentation

- ✍ The emergency generator distribution panel protective coordination study was never provided – had been requested many times. Protective coordination of generator breaker and ATS emergency feeder breakers was never done.
- ✍ Many panelboard circuit directories were missing.
- ✍ As-built drawings had significant inaccuracies.

Electrical Findings – Normal Power System

- ✍ A few circuit breakers were too small.
- ✍ A few circuit breakers were too large.
- ✍ Electrical wiring was too small in a few cases.
- ✍ Temporary wiring remained above some ceilings.
- ✍ Some main switchboard breaker settings were wrong.
- ✍ One transformer's secondary winding was not protected properly.
- ✍ Main switchboard had 7 open holes in its enclosure cover.

HVAC SYSTEMS POST OCCUPANCY Cx LESSONS LEARNED

- ✍ MAJOR HVAC SYSTEMS
- ✍ ENGINEER OF RECORD
- ✍ IMPACT OF VALUE ENGINEERED ITEMS
- ✍ COMMISSIONING AGENT
- ✍ THE MOST IMPORTANT THING

MAJOR HVAC SYSTEMS

- ✍ DESIGN CONCEPT WAS CONFIRMED
- ✍ RIGHT EQUIPMENT WAS CHOSEN
- ✍ EQUIPMENT/SYSTEM DEFICIENCIES WERE DISCOVERED

CUSTOM AIR HANDLING UNITS



CUSTOM EXHAUST UNITS WITH HEAT RECOVERY



CHILLED WATER PLANT



COOLING TOWERS



BOILER PLANT



VARIABLE FREQUENCY DRIVES



ENGINEERS OF RECORD

✍ ENGINEERING FEES AND THEIR EXACT
ROLES ON THE PROJECT

MINIMUM INPUT DURING CONSTRUCTION

MINIMUM INPUT DURING SYSTEM
ACCEPTANCE / POST OCCUPANCY
COMMISSIONING

IMPACT OF VALUE ENGINEERING OF HVAC ITEMS



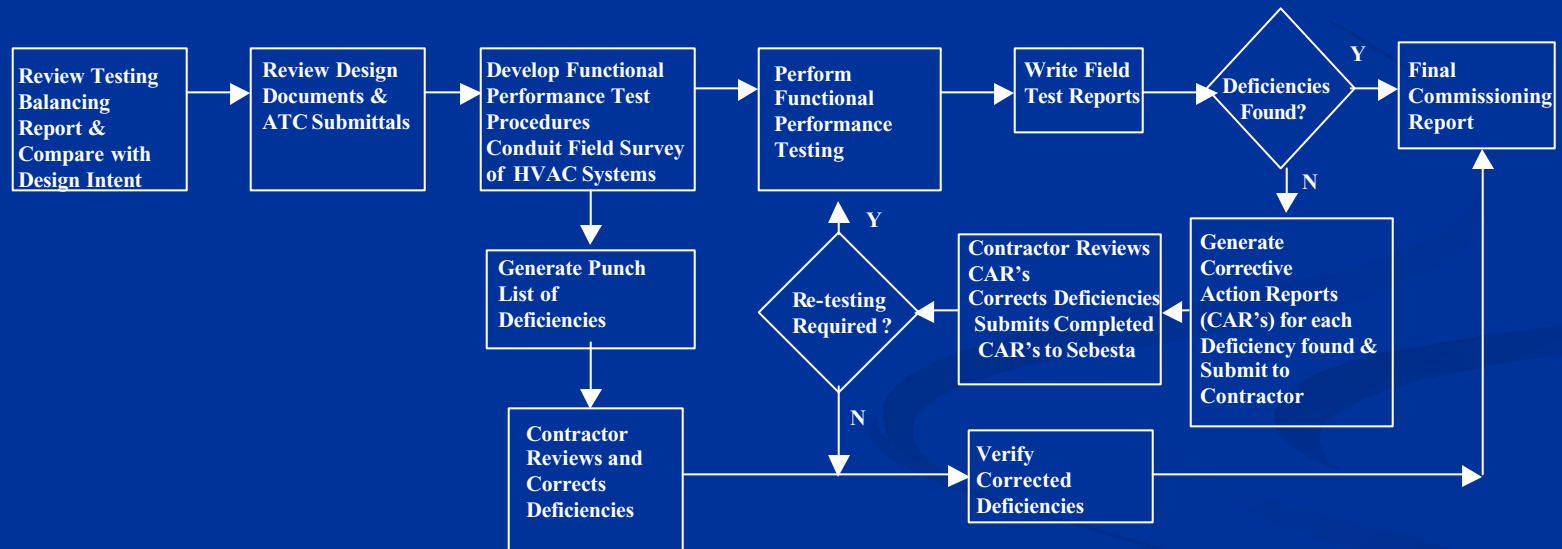
IMPACT OF VALUE ENGINEERING OF OTHER TRADES



COMMISSIONING AGENT

- ✍ REPRESENTING OWNER DURING POST OCCUPANCY COMMISSIONING OF SELECTED SYSTEMS
- ✍ RECORD ALL DEFICIENCIES
- ✍ MEDIATOR

BUILDING 114 - POST COMMISSIONING PROCESS



DEFICIENCY OF CUSTOM AIR HANDLING UNIT CAPACITY

✍ DESIGN: TWO AIR HANDLING UNITS @ 85,000 CFM EACH.

2.50 " EXTERNAL S.P.

0.75 " DIRTY PRE-FILTER

1.50 " DIRTY FINAL-FILTER

1.00" WET COOLING COIL

✍ ACTUAL: TWO AIR HANDLING UNITS @ 75,000 CFM EACH

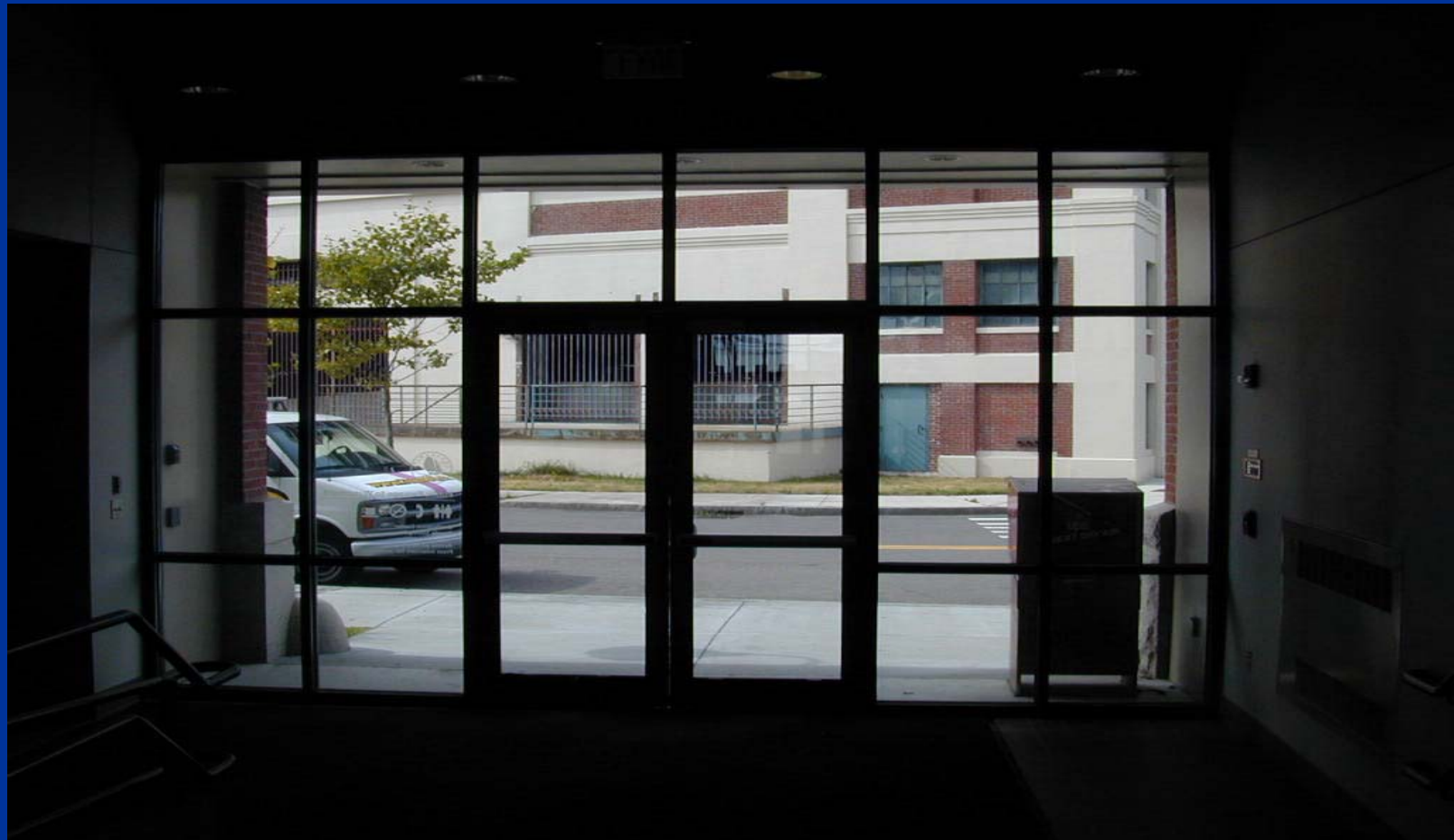
2.00" EXTERNAL S.P.

0.75" DIRTY PRE-FILTER

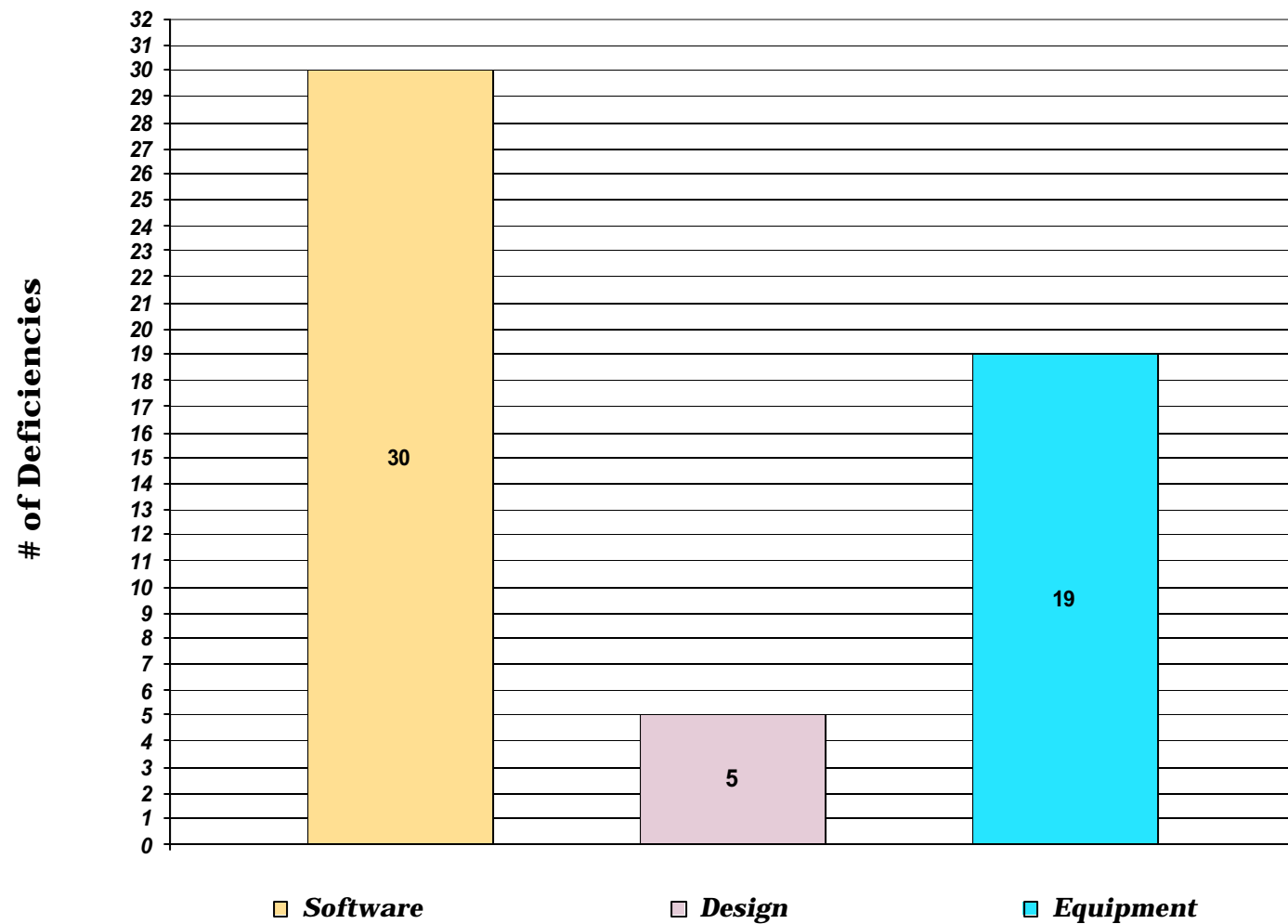
1.50" DIRTY FINAL-FILTER

0.90" WET COOLING COIL

DEFICIENCY OF BUILDING PRESSURIZATION CONTROL SYSTEM



Corrective Action / Deficiencies by Source



THE MOST IMPORTANT THING

DOCUMENTATION